



STEM PEDAGOGY: TEACHING STEM THROUGH PROJECT-BASED LEARNING

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ABSTRACT:

The teaching of science alone without integrating technology, engineering and mathematical concepts does not give graduates the skills they need to excel in the field of research and future careers. This means too that science teaching should not be done in isolation without students seeing and applying in their daily lives the knowledge learned in class. Since the development of this course, STEM for Teacher Educators, we have been shopping around for the best pedagogical techniques of preparing prospective teachers to develop knowledge and useful skills needed to function as professional STEM educators, understanding the relationship of science, technology, engineering, and mathematical concepts. In line with the CSDE framework (2013), we were trying to propose shifts in science teaching and learning to excite and interest more students in STEM connections. We hoped that the results would foster the building of teachers' understanding, efficacy, and competency in STEM pedagogy.

Students formed groups, selected project topics of their personal interest or career aspirations that inspired them. While researching, the students compared the advantages and disadvantages of this PBL in comparison to other traditional teaching methods. The students came out with exciting projects that truly demonstrated a lot of meaningful learning as revealed by the advantages they recorded.

INTRODUCTION

The National Research Council (NRC) of the National Academies believes that the primary driver of the future economy and concomitant creation of jobs will be innovation, largely derived from advances in science and engineering. The NRC (2011) sees STEM as a cultural achievement that reflects people's humanity, power the economy, and constitutes fundamental aspects of our lives as citizens, workers, consumers, and parents. It is even emphasized that an increasing number of jobs at all levels, no matter the field, require a sound knowledge of STEM.

Unfortunately research so far reveals that the method of teaching science these days does not prepare the students for the demands of today's economy and the economy of the future. To support this, Schmidt (2011) states that "roughly 75 percent of U.S. 8th graders are not proficient in mathematics when they complete 8th grade." Gonzales et al (2008) also found out that "U.S. students lag behind the highest performing nations on international assessments. National Governors Association (2007) found out that international students fill an increasing portion of the elite STEM position in the United States.

It is therefore imperative that educators come out with ways and means of teaching that could place the country at competitive levels with other nations. These concerns prompted this research.

PROJECT-BASED LEARNING

Project-based learning (PBL) is considered an alternative to paper-based, rote memorization, teacher-led classrooms. It refers to any programmatic or instructional approach that utilizes multifaceted projects as a central organizing strategy for educating students.

RESEARCH METHOD

In this PBL, students formed groups of at least three and selected project topics of their personal interest or career aspirations that inspired them. Diverse skills required included researching, writing, interviewing, and collaboration among themselves. Time required for execution and completion of their projects was one semester. Projects were designed based on the learning standards (CT science frameworks) for middle and high schools. Students in their project include experiences designed to address real-world problems and issues. Students themselves carried out investigations and analyzed their complexities, interconnections, and Ambiguities. The projects integrate multiple academic subjects (biology, chemistry, physics, earth and space science) and skill areas. Learning process was more student-directed than traditional lectures or quizzes. We still provided ongoing instruction, guidance, and academic support to students. With the ecosystem and water conservations for example, research involved investigating species diversity, and social, economic, and environmental implications for the community.

EXAMPLES OF PROJECT TOPICS

For these couple of years, the project topics included how the principle of friction was important in the design and construction of our highways, healthier school lunches, creation of a school garden for agriculture-inclined students, ecosystem or water conservation, waste management, atmospheric pressure, climate, and cellphone towers. Products of the projects ranged from written papers, power points, posters, and short video clips which could raise awareness of issues among students, faculty and staff.

ASSESSMENT

We assessed student learning progress and achievement of specific learning standards using portfolio and presentations. The laid down rubrics awarded points for the scientific process adopted, the integration of the concepts of the STEM disciplines and the knowledge gained, Colleagues in engineering and technology fields were invited to participate in the panels throughout the research, reviewing and evaluating the research process, presentations and final projects products in collaboration with us teachers.

QUALITY OF PROJECTS

Most of the projects were seen to be of high caliber demonstrating more "integrated" understanding of concepts and knowledge. The content knowledge revealed relevant and practical real-world situations. Written and oral remarks by students indicated that the whole exercise was interesting, engaging, motivating and relevant thus reflecting better ways of learning. These results therefore showed that PBL is a more flexible approach to instruction, projects and assignments tailored to include diverse learning styles and abilities. This clearly indicated that PBL addressed multiple learning standards simultaneously.

LOOPHOLES IN PBL TECHNIQUE

A good number of students were not convinced PBL, though exciting, did ensure that students learned all the required material and standards expected. Since most of these pre-service teachers had majored in only one STEM discipline, they complained that they did not have the time or specialization nor appropriate training required to use PBL. They again saw, as a PBL loophole, the fact that projects selected and designed varied widely in academic rigor and quality. These prospective teachers further feared that PBL could open avenues to watered-down learning expectations and low-quality coursework. Students who lacked self-motivation or who struggled in less-structured learning environments admitted they were not well suited to PBL. A few students complained that PBL raised logistical concerns including learning at home in unsupervised settings with only untrained adult educators around.

CONCLUSION

With the performance of students and their remarks in these STEM projects for these years, there are many reasons to recommend PBL as a teaching method worthy of choosing for STEM courses. Choosing PBL would be a shift in the right direction in science teaching and learning which would excite and interest more students in STEM connections. The advantages seen by using PBL will surely foster the building of teachers' understanding, efficacy, and competency in STEM teaching, thereby effectively leading would-be teachers to attain the desired level of proficiency in integrating Biology, Chemistry, Physics and Earth and Space Science concepts in their teaching.

REFERENCE

Gonzales et al (2008) Highlights from TIMMS 2007. Mathematics and science achievement of US 4th and 8th-grade students in an international context
NRC (2011). Successful K-12 STEM Education, The National Academies Press.
CSDE Retrieved April 2013 from
www.sde.ct.gov/sde/lib/sde/pdf/curriculum/science/ngss_ct_stds_content_crosswalk_report.pdf,